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ALCOHOL FUEL FROM BIOMASS: CHALLENGES OF IMPLEMENTATION IN NIGERIA

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ABSTRACTS
Nigeria is endowed with reasonable high energy resources; around 48 million hectares of land nearly 60% are lying idle because the land is neither used of food nor for raw materials for alcohol production. There are feed stocks for alcohol productions available in reasonable quantity. These are sugar cane, cassava, sorghum, corn, sugar beets, molasses and varieties of fruits, trees and grasses, all these can be converted directly into burnable fuels, termed as "befouls," to assist in meeting transportation fuel demands. The two most widely used types of alcohol fuel are methanol and ethanol. Production of ethanol is by hydrolysis of the starch molecules by enzymes into fermentable sugar. The process is the same for starch, sugar molecules once the fermentable sugar is formed. Methanol and ethanol are both clean fuel that can be produced from locally available, renewable resources, using equipment that a local workshop can make and maintain. This can make biofuels an economical option to fossil fuels and new innovation technologies for the conversion of wood and other biomass resources that are not edible into synthesis gas suitable for production of methanol will make alcohol fuel economic viable. In Nigeria, the development of alcohol fuel will help to increase energy for electricity generation and industrial development and to boost agricultural production of crops for food as well as raw materials for commercial production of alcohol fuel. In this paper efforts were made to compare the properties of alcohol fuel with gasoline , application of alcohol fuels in machines, The challenges of implementation and the constraint towards the much talked about alcohol fuel program in Nigeria were analyzed . The challenges before the Nigerian government are enormous, funding research and information dissemination and encouraging production of food through revamping agricultural production. . This should be done by giving incentives and this will encourage farmers to invest in agriculture and agro-bases industries. These and other factors and the constraint were issued discussed in this paper.

KEYWORDS: Alcohol fuel, biomass conversion, methanol, ethanol, challenges, implementation

INTRODUCTION

The energy profile of Nigeria is characterized by acute shortages of petroleum products and associated with high costs, by unreliable and erratic electric power supply, resulting in power outages, load shedding and power rationing. To provide power for domestic, commercial and industrial purposes, many electric generating plants have been installed as stand-by power sources and operated at high cost to the users. These plants pollute the air, and release carbon monoxide which has resulted in several deaths, (Energy Commission of Nigeria, 2009).

Nigerian Energy biomass are shown in Fig.1

Table 1: Nigeria's Energy resources

S/N	Energy Type	Resource Estimate	Energy Equivalent
1.	Coal & Lignite	$2.7x10^9$ tonnes	61.29 x 10^{12}MJ
2.	Crude Oil	3.42 x 10^9M^3	131.6 x 10^{12}MJ
3.	Natural gas	3.615 x $10^{12}M^3$	139.4 x 10^{12}MJ
4.	Large scale Hydro power	10,000M/W	
5.	Small scale Hydropower	734.2MW	
6.	Wind Power	2.01 – 4.0M/S	
7.	Solar Radiation	3.5 – 7KWh/M^2 day	12.0 – 30.0MJ/M^2 day
8.	Biomass	144 million tonnes/yr	9 x 10^{12}MJ

Energy Commission of Nigeria (2009)

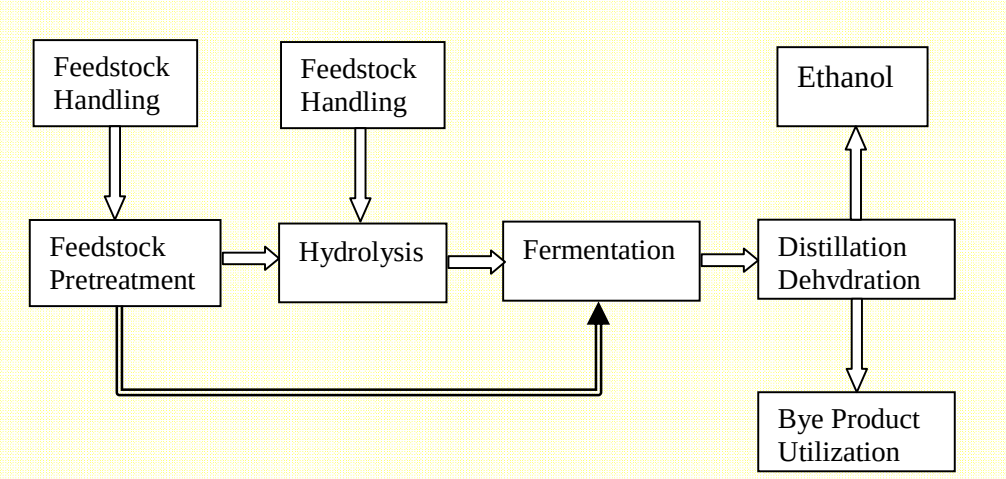
Advanced bioelectricity production from refined solid biomass (agro-pellets), bioethanol, biomethanol and bio-hydrogen is a viable option for energy production. The refined solid biomass can be used for heating, cooling, co-firing with coal. All these types of biofuels (derived from biomass resources) could be produced

Commercially but processing cost still limits the investments. The aim and objectives of this paper are; 1. To compare the properties of alcohol fuel with gasoline.

2. Application of alcohol fuels in machines, and finally
3. The constraint and challenges of implementation in Nigeria

Pre-Treatment of Feed Stock in Biomass Conversion

Feedstock preparation, fermentation and distillation are three processes involved in the ethanol production process. Ethanol can be produces from three main types of biomass feedstock (2) sugars, starches and cellulose. In the case of sugar cane, the cane is first washed, crushes soar as to extract fluid form it and then filtered to separate the bagasse. The resulting liquid would be treated by steaming so as to sterilize and concentrate before fermentation (Charles and Essel, 2002)



Charles and Essel (2002)

Fig 1: General Diagram of Bioethanol Production

Bioethanol is produced through the conversion (fermentation) of sugars to ethanol. The biomass that exists as complex sugars (polysaccharides) are however first broken down into fermentable sugars through a process of chemical reaction called hydrolysis see Figure 1.

The simplified fermentation reaction equation for the simple 6-carbon sugar, glucose is:

Biomass crops used for alcohol and their fermentable sugars are shown in the Table 3 and 4.

$$\underset{\text{(Glucose)}}{C_6H_{12}O_6} + \text{Zymase} \longrightarrow \underset{\text{(Ethanol)}}{2CH_3CH_2OH} + \underset{\text{(Carbon Dioxide)}}{2CO_2}$$

Uses of Alcohol as Fuel

- It is used as fuel and gasoline additive (eg Gasohol)
- It is used in the manufacture of alcohol drinks
- It is used in preservation of specimen for laboratory works
- As ant freezing agent
- Used in the manufacture of acetaldehyde, ethanol and acetic acids

PERFORMANCE OF ETHANOL IN AUTOMOBILES

Occurrences of plugged fuel filters are virtually non-existent with alcohol fuel. The “cleansing” nature of ethanol blended fuels can actually keep the fuel system cleaner and lead to improved performance. In the case of dirty fuel systems, contaminants and residues that have been deposited by previous gasoline fill can be loosened. That residue can get caught in the fuel filter. In older cars, especially those
made prior to 1975, replacing the filter solves the problem from that point on—and once car’s fuel system is clean, car’s performance should improve as well.

The formulation of gasoline has changed dramatically over the past few years without affecting the performance of older cars. Many older cars were designed to run on leaded gasoline, with the lead providing necessary octane performance — and the lead oxides that were formed during combustion provided a cushion that reduced wear on non-case-hardened valve seats. When lead was phased out of gasoline, oil companies added toxic chemicals to raise the octane rating — and other additives to replace the “lubrication” value of lead. Ethanol added to gasoline increases the octane level of the final fuel by three points — and it does so using a natural, renewable additive that works well in older engines.

PERFORMANCE IN SMALL ENGINES

Ethanol blended fuel is perfectly acceptable in lawn mowers, snow mobiles, and other small engines. Manufacturers of this equipment know that more than 40% of the gasoline sold across the U.S. contains oxygenates, such as ethanol, so they’ve made certain that their engines perform using clean-burning fuels. Ethanol blends may be used anywhere that unleaded gasoline is used—
Chainsaws, from lawn mowers to personal watercraft. Virtually every small engine manufacturer, including Briggs & Stratton, Honda, Toro/Lawnboy, Kohler, and Snapper, approves the use of ethanol-blended fuel in its equipment.

With the incredible growth in ethanol production,

Table2: Liquid Fuel from Biomass compared

1.	Net Productivity (toeha^{-1} Year^{-1})	Methanol is greater more favourable than ethanol
2.	Economics	Methanol is favourable
3.	Potential of Resources (Biomass, coal etc)	Methanol is favourable
4.	Pressure on Agricultural land	Methanol is favourable
5.	Technical feasibility	Methanol is favourable
6.	Industrial development	Ethanol is greater than methanol
7.	Utilization as motor fuel	Methanol = Ethanol

Conclusion: Methanol is Preferred for Mobile Power (Lynd et.al, 1991).

Production Of Methanol From Wood Through Gasification

The commission of the European Committee launched a series of pilot biomass gasification projects with a capacity of 12-60 t/day, producing synthesis gas of a quality suitable for methanol production. Production of methanol from synthesis gas is a proven technology. Table.2. Compares the properties of methanol and ethanol

To gain experience with a variety of prospective process concept, each project will develop a different technology, though in all cases, the final aim in similar production of a clean synthesis gas, virtually free of hydrocarbons, low in nitrogen; (Lynd et.al, 1991).

Recent review confirms that the production of methanol will probably be the preferred large scale option relative to methane and ethanol.

Furthermore, if gasoline production from biomass is ever to become feasible, indirect synthesis via methanol seems to be more promising than the fisher-Tropsch alternative.

Many studies on the feasibility of methanol from wood have been published , particularly in the US but also in Europe.

Feasibility and viability will also be influenced by the way the plant can be integrated (for example independent – located in the middle of an easy plantation; or integrated into a power station where part of the synthesis gas is burned directly and another part is used to produce methanol either as the peak shaving fuel or for integration with methanol plant) (Lynd 1989; Lynd et. al, 1991;Wyman, 1990)

The last option is relatively attractive because of possible favourable effects related to the mixing of two synthesis gas streams, one with a too high, and the other attractive low H_2/CO ratio. Table 3. Compare the properties of the alcohol fuel with gasoline.

In 2006, U.S. corn farmers produced a near record 10.74 billion bushels of corn. Of that, 1.8 billion bushels went to the production of ethanol and co-products—so there is plenty of room to expand ethanol production without limiting the availability of corn. Average corn yields continue to increase and other nations are growing more corn as well, so the supply continues to grow. At the same time, new raw Materials for ethanol production are being developed including cornstalks, switch grass, vegetable matter, waste from paper/pulp production, and other“cellulosic” sources, see Table 4 and 5

In Nigeria, the development of fuel will help to boost agricultural production of crops for food as well as raw materials for commercial production of Alcohol fuel.

Challenges of alcohol fuel utilization

1. Low public awareness of sustainable energy methodologies.

Table3. Properties of Fuel Alcohols Compared with Gasoline

Property	Fuel Alcohols		Gasoline (for comparism)
	Methanol	Ethanol	
Density kg/M^3	789	793	720 – 750
Heating Values Higher MJ/kg	29.7	22.3	46.47
Lower MJ/kg	27.0	19.7	43.6 – 43.9
Lower MJ/M^3	21.3	13.6	About 32
Stoichiometric Air/Fuel ratio (kg/kg)	9.0	6.5	14.6
Heating value for Stoichiometric air/fuel mixture		2.68	2.71
Bioling temperature at 1 bar^{0}C	78.5	65	30.225
Heat of Vaporization (KJ/kg		1110	400
Vapour Pressure at 38^{0}C		32	62 – 90
Viscosity Stake		0.58	0.6
Octane Number research	106	112	91- 100
Motor	89	91	82 – 92
Certain number	15	10	

Lynd et. al, (1991)

Table 4: Some Bioethanol Feedstocks and their Annual Yield/ha

Crop	Annual Yield Litres/Hectares	Green house gas savings (% vs Petrol)	
Miscellanies	7300	37 – 73	Reference: Energy Commission of Nigeria Biofuel Training Manual (2009)
Switch grass	3100 – 7600	37 73	
Poplar	3700 – 6000	51 – 100	
Sugar Cane	5300 – 6500	87 – 96	
Sweet Sorghum	2500 – 7000	No Date	
Corn	3100 – 3900	10 - 20	

Table5: Average Fermentable Sugar Content of Some Saccharine feedstocks

Fruit	Average Fermentable Sugar Content (%)
Grapes	15.0
Bananas	13.8
Apples	12.2
Pineapple	11.7
Pears	10.0
Peaches	7.6
Oranges	5.4
Water Melon	2.5
Tomato	2.0
Feedstocks	Average Fermentable Sugar Content (%)
Sugar Beets	15.0
Sweet Sorghum	14.0
Sugar cane	10.0 – 15.0
Molasses	50.0 – 55.0

Energy Commission of Nigeria(2009)

2.Appreciable energy R & D results but yet to be commercialized.

3.Investors appear reluctant to establish manufacturing plants to locally produce:

- Energy end-use technologies.
- Power plant components.

4. Energy utilization in the economy appears uncoordinated.

5. Funding for Research, Development, Demonstration and Diffusion (R,D,D and D) activities is grossly in-adequate.

Implementation Issues
These implementation options for all Energy resources have been proposed by the Energy Commission of Nigeria

1.Intensifying R & D and establishment of more pilot projects to further promote sustainable energy use.

2. Developing partnerships with the private sector to establish manufacturing plants to market energy R&D results and to locally produce energy end-use technologies.

3. Establishing a one-stop-shop to provide information and guidance to would-be-investors in the energy sector.

4.Laying down guidelines on the utilization of energy types for specific purposes and in a prescribed sequence.

5.Monitoring the performance of the energy sector in the execution of Government policies on energy.

Entrenching energy planning in the economy by getting the National Energy Policy (NEP) and the Nationa Energy Master plan (NEM) to be passed into law by the National Assembly and mainstreamed into the overall national development programmes. These will include the National Energy Databank and the National Energy Manpower Development Plan, for the Sector.

6.Dedicating 2% of the income from the energy sector to fund Research, Development, Demonstration and Diffusion programmes in the sector

The Challenges before the Nigeria Government
Incentives to Farmers
One of the challenges before the Nigeria government is to encourage the production of food through revamping agriculture. This should be done by giving incentives and this will encourage farmers to invest in agriculture and agro-bases industries.

Increasing Energy Generation to sustain Biofuel Industries
Nigeria is currently facing a crippling energy crisis. The energy output is put at mere 1400 mega watts (MW). For the country to grow industrially, the energy generated should be in the neighbourhood of 30,000MW.

Provision of adequate land for crops production
In Nigeria around 48million hectares or nearly 60% the capacity us lying idle because the land is neither used of food nor for raw materials for alcohol production. It therefore makes more economic sense for the country to put the land into crop cultivation for alcohol fuel production.

Encouraging the Initiatives of Public and Private Agencies to promote Biofuels Production
Nigeria National Petroleum co-operation (NNPC) has created a Renewable Energy Division (RED) to spearhead the development of biofuel industry in the country. Onyekakeyah (2008) RED has launched a biofuel initiative by inviting Expression of interest (EOI) to enlist joint-venture investors into the country.

Global Biofuels Limited, a private sector company, has also initiated the construction of Nigeria's first biofuel refinery at Arigidi – Akoka in Ondo State. Other large scale biofuel projects are being initiated in Jigawa and elsewhere.

Increased funding of Research and Development Centres for Infrastructure Development, Acquisition of Research equipment, Manpower development and training.

Alcohol fuel holds great prospects for agricultural and industrial development as well as meeting the energy demands of the Nigerian populace.

At the moment it is still at experimentation stage or pilot plants stage mostly in the research institutions and tertiary institutions.

CONCLUSION

Alcohol fuel a clean fuel which when harnessed and appropriate technology for its production developed will help boost energy production for industries, automobiles and economic development and this will definitely reduce over dependence in fossil fuel, with the abundance biomass resources, encouragement from the government is all that is needed for its full scale take off in Nigeria

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